MAR12-2011-002187

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Fluctuations of Superconductivity in $La_{2-x}Sr_xCuO_4$: A Terahertz Conductivity Study[1]

LUCAS BILBRO, The Institute for Quantum Matter, Department of Physics and Astronomy, Johns Hopkins University

In the underdoped pseudogap regime of the high-temperature superconductors, one expects that due to low superfluid densities and short correlation lengths, superconducting fluctuations will be significant for transport and thermodynamic properties. However, there has been disagreement about how high in temperature they may persist, their role in the phenomenology of the pseudogap regime, and their significance for understanding high-temperature superconductivity. We use THz time-domain spectroscopy (TTDS) to probe the temporal fluctuations of superconductivity above the critical temperature (T_C) in $La_{2-x}Sr_xCuO_4$ (LSCO) thin films over a doping range that spans almost the entire superconducting dome. Signatures of the fluctuations persist in the conductivity in a narrow temperature range above T_C. Our measurements show that superconducting correlations do not make an appreciable contribution to the charge transport anomalies of the pseudogap in LSCO at tempera tures well above T_C.[2] I will compare our results for an underdoped (x=0.095) sample with measurements of diamagnetism in a similarly doped crystal of $La_{1.905}Sr_{0.095}CuO_4$. I will show, through a vortex-plasma model, that if the fluctuation diamagnetism originates solely in vortices, then these vortices must exhibit an anomalously large vortex diffusion constant, more than two orders of magnitude larger than the Bardeen-Stephen estimate.[3] This points to either the extremely unusual properties of vortices in the underdoped d-wave Cuprates or a contribution to the diamagnetic response that is not superconducting in origin. Finally, I will introduce preliminary results of THz conductivity measurements of critically underdoped LSCO films, where superconductivity is fully suppressed.

[1]Work supported by The Institute of Quantum Matter under DOE grant DE-FG02-08ER46544, the Gordon and Betty Moore Foundation, and the US DOE under Project No. MA-509-MACA.

[2]L.S. Bilbro *et al.*, Nature Physics 7, 298 (2011).

[3]L.S. Bilbro *et al.*, Phys. Rev. B 84, 100511 (2011).